

System Specification

LDB Interface Phase I Thread, Thor DP1

Checkout and Launch Control System (CLCS)

84K00302-008

Launch Data Bus Interface Phase 1 Thread Assessment

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Version 1.0

Launch Data Bus Interface Phase 1 Thread Assessment

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1. Introduction

1.1 Launch Data Bus Interface Phase 1 Thread

This thread establishes the initial capability to monitor and command the Launch Data Bus. The Launch Data Bus (Launch Data Bus) is the interface between the Orbiter data processing system and all applicable ground facilities for test, checkout, maintenance, preflight, and post-flight phases. In addition, this common software interface provides the RTPS with access to the devices that are attached to the Launch Data Bus when the General Purpose Computers (GPC) are not active on the Launch Data Bus. A simple application display will be developed to demonstrate LDB end item command capability.

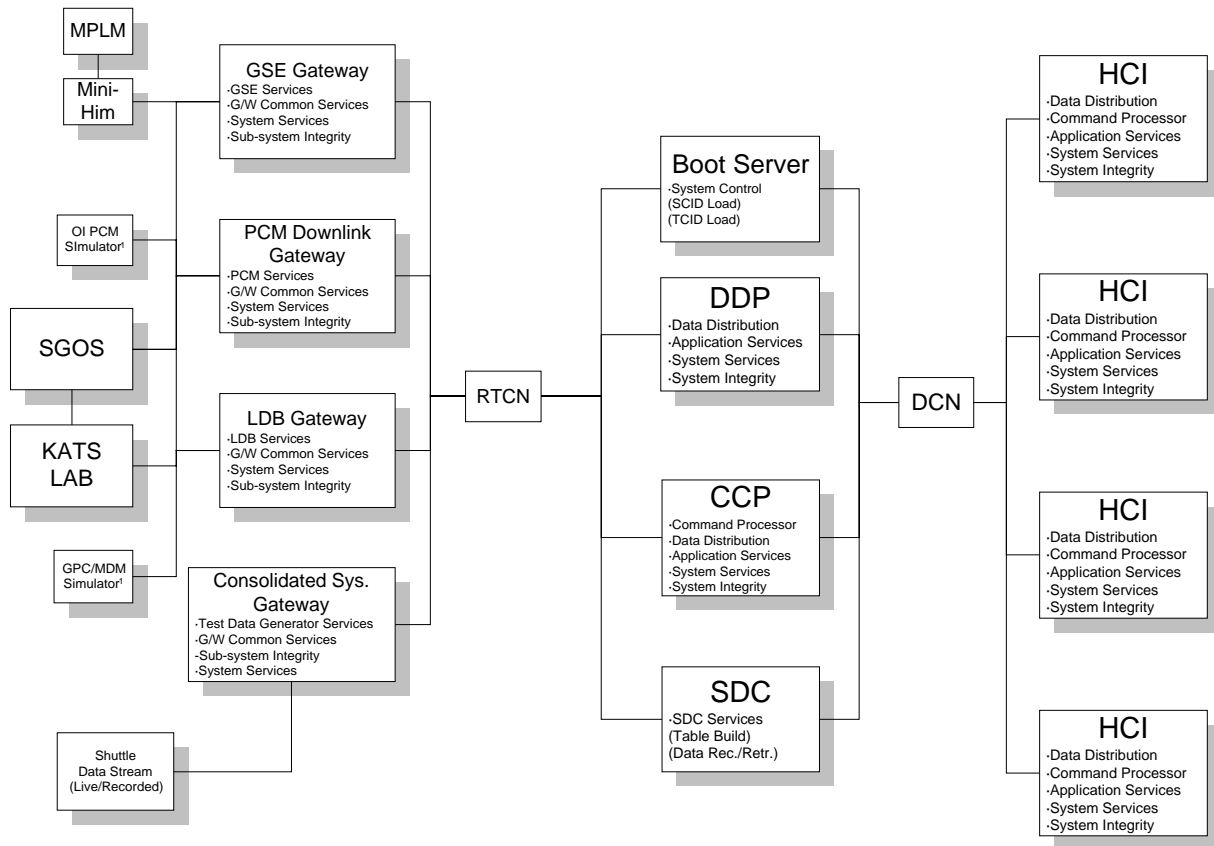
Highlights:

- Basic Launch Data Bus function in SACS and TCS-1 mode.
- GPC Memory Reads
- GPC Memory Writes
- DEU Keystrokes

1.2 Launch Data Bus Interface Phase 1 Thread Concept

To provide Launch Data Bus Interface Phase 1 support as defined in the Thor Delivery Document Section 6.2.4 requires support from the LDB Gateway and all other major CLCS Systems.

Launch Data Bus Interface Phase 1 Thread Concept Diagram



1. Gateway Team developed test tools

1.3 Launch Data Bus Interface Phase 1 Thread Specification

1.3.1 Statement of Work

- A GPC simulator will be developed to provide simulated Launch Data Bus polling, accept Launch Data Bus data transmissions, and provide a limited set of simulated GPC responses. The GPC simulator will provide Launch Data Bus polling on either bus, provide bus switching, and provide limited error injection capabilities. The GPC simulator will be used to verify Launch Data Bus gateway bus communications in a standalone environment.
- A Launch Data Bus monitor will be developed to capture, time tag, and record all Launch Data Bus traffic on both buses. The Launch Data Bus monitor will be used to verify Launch Data Bus gateway bus communications in a standalone environment as well as at the KATS lab.
- A TCL shell based CCP simulator and associated GUI will be developed to send simulated RTCN packets to and receive simulated RTCN packets from a Launch Data Bus Gateway via Ethernet.
- A single-string non-redundant Launch Data Bus Gateway prototype will be developed which will accept and queue commands from a CCP simulator, transmit the commands to a GPC located in the KATS lab, receive responses from the GPC, and return the response to the CCP simulator for display. Commands from and responses to the CCP simulator will be sent via Ethernet utilizing RTCN payload formats.
- The following SACS and TCS-1 commands will be implemented:

Route Code	Request ID	150 OP Code	Operator	Description
11	1, 51-54	3	ISSUE	Issue Command to GPC (MDM only)

11	2	4	G-MEM Write	Write to GPC Memory
11	24	5	G-MEM Read	Read from GPC Memory
11	3	6	EQ DEU	Send Simulated Keystrokes to GPC
11	20	7	LDB CNTL	Control LDB Polling
11	42, 57-60	8	READ	Read Command from GPC (MDM only)
11	46	13	TEXT	Send DEU Text Messages to GPC

- Basic Launch Data Bus Gateway tables will be defined and a Launch Data Bus Gateway initialization and table load process will be developed. Launch Data Bus Gateway hardware safing tables and initialization will not be developed for Thor.
- Capability to receive a CCP generated Launch Data Bus command, transmit the command to the GPC simulator, receive a response from the GPC simulator, and return the response to the CCP will be developed.
- Provide the capability to perform Launch Data Bus operation using command processing and command management from an application or command processor
- Provide the application services required to support display of Launch Data Bus data.
- Provide a user display capability to control Launch Data Bus functions
- Build, load, distribute, and initialize all TCID table and SCID software require to support Launch Data Bus operation.

1.3.2 Requirements

SLS Requirements Addressed in this thread:

- (SLS - 2.1.1.1) Launch Data Bus (LDB) Interface

The Launch Data Bus (LDB) is the interface between the Orbiter data processing system and all applicable ground facilities for test, checkout, maintenance, preflight, and post-flight phases. In addition, this common software interface provides the RTPS with access to the devices that are attached to the LDB when the General Purpose Computers (GPC) are not active on the LDB.

The LDB is a burst-mode asynchronous bi-phase Manchester II encoded 1 Mbs data bus using 28 bit words. There are two identical, independent Launch Data Buses. The two LDBs may be used as a redundant pair, or may be used independently, as needed.

Although part of the LDB is a true bi-directional, half-duplex, redundant data bus, most of the ground portion of the bus consists of two sets of unidirectional data lines; two Uplink buses and two downlink buses. The LDBs are simplex data buses between the RTPS gateway and the Orbiter LPS Signal Adapter (OLSA), and half-duplex serial buses between the OLSA and the Orbiter. At the interface to the RTPS Gateway, the electrical signal is a differential 2 VP-P +/- 0.2 VP-P at 124 Ohms balanced.

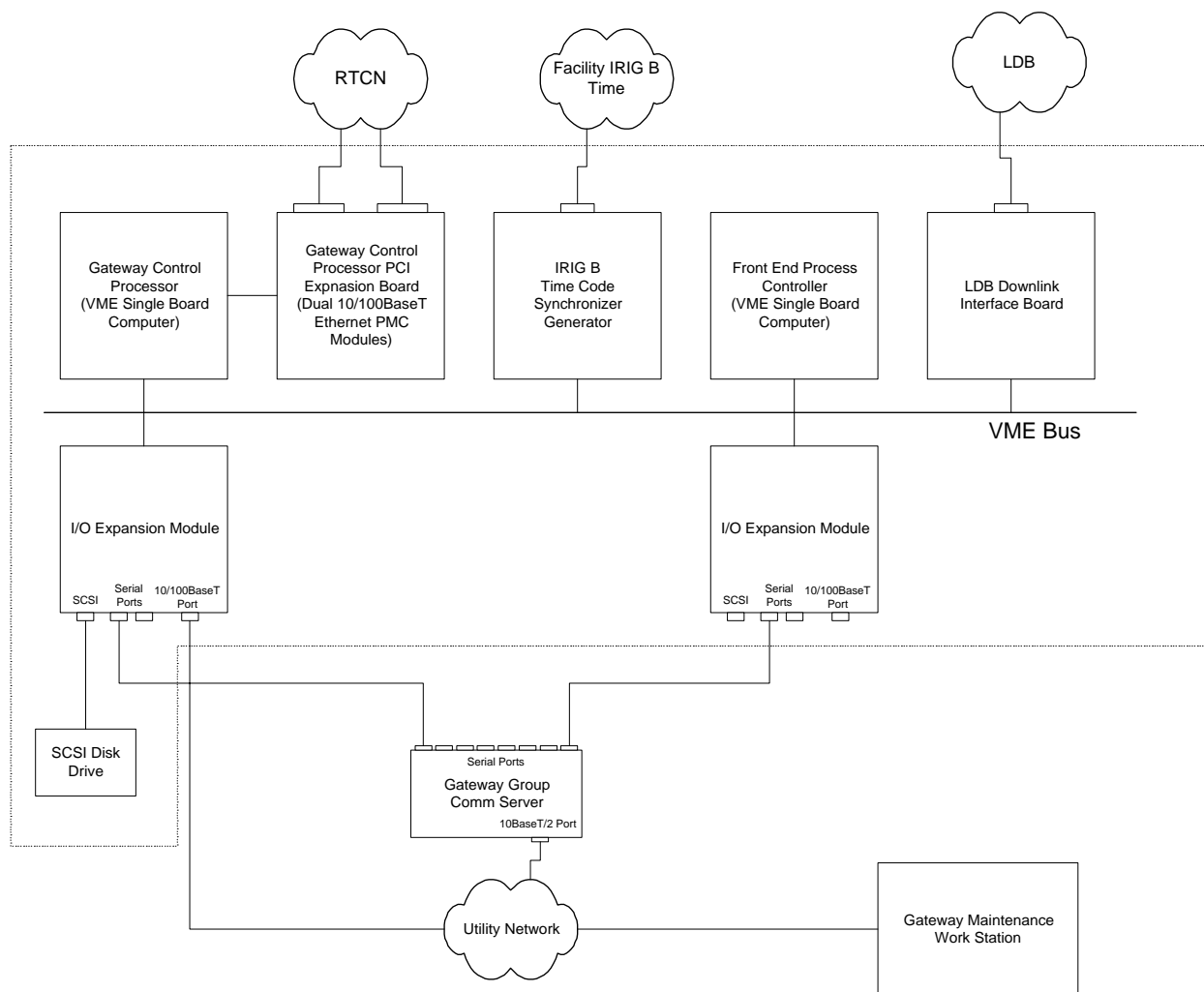
- (SLS - 2.1.1.1.1) The RTPS shall meet the requirements allocated to the LPS/LDB interface specified in:
 1. SS-P-0002-150, Space Shuttle LDB Software Interface Requirements
 2. ICD-2-0A003, Section 3, Flight Vehicle/LPS Computational Systems Interface
- (SLS - 2.1.1.1.2) The RTPS shall provide the capability, in GPC Mode, to issue commands and to receive measurement data, via the GPCs, from:
 1. Orbiter Multiplexers/Demultiplexers (MDM) (i.e., Flight Critical, Payload, Flex, SCA, and Command Decoders)
 2. Master Events Controller (MEC) (*Not supported for Thor*)
 3. Pulse Coded Modulation Master Units (PCMMU) (*Not supported for Thor*)
 4. Mass Memory Units (MMU) (*Not supported for Thor*)

5. SSME Controllers *(Not supported for Thor)*
 6. Solid Rocket Booster (SRB)MDMs *(Not supported for Thor)*
 7. Engine Interface Units (EIU) *(Not supported for Thor)*
 8. Payload Data Interleaver (PDI) *(Not supported for Thor)*
 9. Payload Signal Processor (PSP) *(Not supported for Thor)*
 10. Space Lab (SL) Experiment/Subsystem Computers *(Not supported for Thor)*
 11. Display Electronic Units (DEU)
- (SLS - 2.1.1.1.4) The RTPS shall provide the capability to interface with all GPC Functional Destinations available via the LDB.
 1. Systems Software Avionics Command Support (SACS)
 2. Test Control Supervisor Single Commands (TCS-1)
 3. Mass Memory (MM)/Display Electronics Unit (DEU) Read
 4. Space Shuttle Main Engine (SSME) Load Program (SLP) *(Not supported for Thor)*
 5. Launch Sequence (LS) *(Not supported for Tho)*
 6. Test Control Supervisor Test Sequences (TCS-S) *(Not supported for Thor)*
 7. Continuation of previous TCS-S sequence containing the same transaction ID *(Not supported for Thor)*

1.4 Launch Data Bus Interface Phase 1 Thread Hardware Diagram

The following diagram illustrates the major hardware elements in the LDB Gateway. The hardware elements enclosed by the dashed line reside in the Gateway VME Chassis.

LDB Gateway Hardware Diagram



1.5 Launch Data Bus Interface Phase 1 Thread Deliverables

Software:

Deliverable	R&D Document	Code	API Manual	Users Guide
LDB Services CSCI	X	X		

Hardware:

Deliverable	R&D Document	Drawings	Prototype	Users Guide
LDB Gateway SDE-1			1	
LDB Gateway SDE-2			1	
LDB Gateway IDE-1			1	

1.6 Launch Data Bus Interface Phase 1 Thread Assessment Summary

This section contains the summary of the costs and labor involved in implementing Launch Data Bus Interface Phase 1 Thread capability. It is broken into three sections. The first is a summary of the individual CI (CSCI and

HWCI) labor assessments. The second is a summary of hardware costs. The third is a summary of procurement activities needed.

1.6.1 Labor Assessments

The total Labor Costs required to provide this capability are summarized in the following table;

No.	CSCI/HWCI Name	Thor LM	Changes covered in
1	LDB Services CSCI	22	Launch Data Bus Interface Phase 1 Thread
2	Launch Data Bus Interface Board	2	Launch Data Bus Interface Phase 1 Thread
3	Gateway Control Processor/Front End Processor Controller HWCI		GSE and Gateway Common Services Completion Thread
4	Gateway IRIG-B Interface Board HWCI		GSE and Gateway Common Services Completion Thread
5	GCP Common Services CSCI		GSE and Gateway Common Services Completion Thread
6	Test Build & Control	18	Launch Data Bus Interface Phase 1 Thread Completion Thread
7	System Services CSCI (System Control CSC)		System Services Enhancement Thread
8	Command Support CSCI		Commanding and Command Processor Phase 2 Thread
9	Data Distribution		Data Distribution Completion Thread
10	System Services		System Control
11	Application Services		Data Distribution Completion Thread/Commanding and Command Processor Phase 2 Thread
12	System Viewer		System Viewers Thread
13	Data Recording/Archival and Retrieval		Log, Record and Retrieval Phase 1 Thread
	TOTAL	42 LM	

1.6.2 Hardware Costs

All LDB hardware to support development efforts in the SDE 1, SDE 2, and IDE 1 with the exception of the LDB Interface Board is currently on hand or already on order.

The total Hardware Costs required to provide this capability are summarized in the following table:

Item number	Name	Unit Cost	Qty.	Total	Assumptions
1	LDB Interface Board	\$12,000	5	\$60,000	New Buy

1.6.3 Procurements

Pre-production LDB Interface Boards will be procured to support Thor Launch Data Bus Interface Phase 1 Gateway development activities.

Procurement Activity	Completion Date
----------------------	-----------------

Procurement Activity	Completion Date
Define LDB Interface Board Requirements	10/17/97
Submit Purchase Request to Procurement	10/21/97
Award Contract	10/24/97
Receive LDB Interface Boards	11/24/97

1.7 Launch Data Bus Interface Phase 1 Thread Schedule & Dependencies

1.7.1 Schedule

Task Name	Start	Finish
Thor Assessment Kickoff	9/8/97	9/8/97
Concept Panel Internal Review	9/23/97	9/23/97
Concept Panel	9/25/97	9/25/97
Thor Development		
LDB Services CSCI Requirement Panel Internal Review	11/4/97	11/4/97
LDB Services CSCI Requirement Panel	11/6/97	11/6/97
LDB Services CSCI Design Panel Internal Review	11/4/97	11/4/97
LDB Services CSCI Design Panel	11/6/97	11/6/97
Gateway Common/ LDB Services CSCI Unit Testing	1/2/97	1/16/97
Gateway Common/ LDB Services CSCI Development Integration Test	1/19/97	1/16/97
Gateway Common/ LDB Services CSCI Formal Integration Test	2/16/97	2/20/97
Support System Integration Test	2/23/98	3/27/97
Thor Development Complete	3/27/97	3/27/97

1.7.2 Dependencies

No.	Dependency Area	Dependency	Need Date
1	Test Build and Control	LDB Tables	12/12/97

1.8 Launch Data Bus Interface Phase 1 Thread Simulation Requirements

The Launch Data Bus Interface Phase 1 Thread will utilize the existing LPS Simulation System with the math models. The LDB Gateways in SDE 1 and SDE 2 will be connected to the VSIs in the LCC via the PCC RCVS and the LDB Gateway in the IDE 1 will be connected to the VSIs via the VSI T/R System. All simulations will be conducted in the real-time mode.

1.9 Launch Data Bus Interface Phase 1 Thread Integration and System Test

Launch Data Bus Interface Phase 1 Thread testing is composed of two major activities:

- Common Gateway Services CSCI/LDB Services CSCI will utilize Gateway Test Tools (Change Data Packet Analyzer/CCP Simulator/GPC Simulator) for development and formal CSCI Integration Testing. A network analyzer may also be used to verify packet structure, data content and timing information.
- System Integration and Test will develop a test plan and test procedures to verify end to end data flow through the system

1.10 Launch Data Bus Interface Phase 1 Thread Training Requirements

None.

1.11 Launch Data Bus Interface Phase 1 Thread Facilities Requirements

- KATS Lab - Add LDB Bus-2 VSI line patch, similar to LDB Bus-1 capability
- Gateway Lab - Add LDB Bus-1 and Bus-2 interface lines.

1.12 Launch Data Bus Interface Phase 1 Thread Travel Requirements

N/A

1.13 Launch Data Bus Interface Phase 1 Thread Action Items/Resolution

See issues listed in individual CSCI assessments.

2. Launch Data Bus Interface Phase 1 Thread CSCI Assessments

2.1 Launch Data Bus Assessment

All the activities described in this section refer to CSCs that will reside on the Launch Data Bus (LDB) Gateway Front End Process Controller.

LDB Gateway System Integrity

To be supplied by system integrity team.

LDB Gateway Initialization

The following capabilities appropriate for Thor will be provided:

- Load FEPC tables
- Attach to command/response streams

LDB Gateway Common Services

Miscellaneous LDB re-usable/sharable software modules and libraries appropriate for Thor including:

- LDB Transaction ID services
- Priority List Manager
- Free List Manager
- Watch Dog Timer services
- LDB Logging services

LDB Gateway Process CCP Request

The LDB commands to be supported by this delivery are provided in the Thor delivery document. Software functions developed to the level pertinent to this support are:

- LDB Command Server
- 150 Command Formatting
- 150 Response Handler
- Table Access services
- Engineering Unit Conversions
- Local Command Handler

LDB Gateway Bus Communications Processing

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Basic

Capability to send commands to the GPCs (in GPC polling mode only) and match up responses received for the commands indicated in the Thor delivery document for the LDB. Software functions developed to the level pertinent to this support are:

- Bus Command Processing for GPC polling mode
- Bus Response Processing for GPC polling mode
- Block Funnel Log services

LDB Gateway Bus Interface Control

Capability to configure and control the Western Avionics Shuttle Bus Interface (SBI) board appropriate for Thor delivery (in GPC polling mode only). Software functions developed to the level pertinent to this support are:

- Generic SBI Control
- Bus Interface Control for GPC polling mode

LDB Gateway Safing System Interface

Not addressed for Thor delivery.

LDB Gateway Redundancy Management

Not addressed for Thor delivery.

LDB Gateway System Checkout/Diagnostics

Not addressed for Thor delivery.

LDB Gateway Bus Monitor

Add capabilities appropriate for providing bus monitor functions in support of Thor deliverables.

LDB Gateway GPC Simulator

Add capabilities appropriate for providing LDB polling GPC simulator functions in support of Thor deliverables.

CSCI Assessment

CSC Name	CSC Current LOC	CSC Thor New LOC	CSC Thor Total LOC	CSC Total % Complete
LDB Gateway System Integrity	TBS	TBS	TBS	TBS
LDB Gateway Initialization	200	800	1000	50
LDB Gateway Common Services	1800	2500	4300	50
LDB Gateway Process CCP Request	2000	6000	8000	30
LDB Gateway Bus Comm Processing	1100	1900	3000	30
LDB Gateway Bus I/F Control	4200	300	4500	75
LDB Gateway Safing System I/F	n/a	n/a	n/a	n/a
LDB Gateway Redundancy Mgmt	n/a	n/a	n/a	n/a
LDB Gateway System Checkout/Diag	n/a	n/a	n/a	n/a
LDB Gateway Bus Monitor	600	400	1000	50
LDB Gateway GPC Simulator	2100	1400	3500	50

Total Labor Months: 22

Documentation

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	New	10
Test Procedure	New	2

Assumptions

Applications software appropriate for sending the commands identified in the Thor Delivery document are available.

Open Issues

Although not required for Thor, software being developed now must provide hooks for the following future capabilities:

1. Special power failure recovery initialization modes for LDB safing.
2. Hard disk separate from GPC for booting LDB FEPC board and storing safing sequences and restart parameters.

2.2 Test Build and Control Assessment

The Test Build and Control CSCI will include support for LDB data.

CSC DBSAFE Work Required

DBSAFE will be modified as required to support LDB FDs. Delete any CCMS specific information from DBSAFE that isn't required by CLCS and make modifications to data as necessary.

CSC FD Directory Work Required

Provide any changes necessary in FD Directory and OLDB to support LDB Processing.

CSC CLCS Gateway Table Build Work Required

Create necessary Gateway Tables to support processing of LDB data.

Basis of estimate

CSC Name	CSC Labor (LM)	% of CSC
DBSAFE	tbd	tbd
FD Directory Build	tbd	tbd
Gateway Table Build	18 LM	90%

Documentation

Provide your assessment of the kinds and amount of documentation that must be provided with the capability.

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	update	tbd
Users Guide	update	tbd
API Interface Document	n/a	n/a
Interface Design Document	n/a	n/a
Test Procedure	update	tbd

Assumptions

None

Open Issues

Require the specification of Gateway Table formats before coding can start.

3. Launch Data Bus Interface Phase 1 Thread HWCI Assessments**LDB Interface Board HWCI Assessment****Labor**

HWCI Name	HWCI Labor (LM)	% of HWCI
Launch Data Bus Interface Board Evaluation	2	100

Equipment

Equipment Type	Quantity	Unit Cost Estimate	Total Cost
LDB Interface Board	5	\$12,000	\$60,000
Total			\$60,000

Documentation

Document Type	New/Update	Number of Pages
Requirements and Design Documentation	New	15
Users Guide	COTS	TBD
Drawings	New	4
Interface Design Document	COTS	4
Test Procedure	New	4

Assumptions

None.

Open Issues

None.

4. COTS Products Dependencies**4.1 SW Products Dependency List**

Product Name	Quantity Needed	Need Date
VxWorks SENS Release	1	11/1/97

4.2 HW Products Dependency List

Product Name	Quantity Needed	Need Date
SPANS PCI Expansion Modules	3	10/17/97
100BaseT PMC Modules	6	10/1/97
LDB Interface Board	5	11/24/97
SCSI Disk Drives	3	10/1/97
MVME 2604 SBC w/ 761 Module	3	10/1/97